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Effect of dynamic bed topography on turbulent flow structure in a gravel-bed river ARVIND SINGH, FERNANDO PORTE-AGEL, EFI FOUFOULA-GEORGIOU, University of Minnesota — A series of flume experiments were conducted at St. Anthony Falls Laboratory, University of Minnesota to study the effect of bedform dynamics on the flow over a gravel bed comprised of a wide distribution of grain sizes. Instantaneous high-frequency velocities were sampled using ADV at a frequency of 200 Hz, while the simultaneous bed elevations were sampled using SONAR transducers at a frequency of 0.1 Hz. Spectral analysis of the measured velocity fluctuations reveals the existence of two distinct power-law scaling regimes. At high frequencies, an inertial subrange of turbulence with Kolmogorov scaling is observed. At low frequencies, another scaling regime with spectral slope of about -1.1 is found. This range is the signature of the evolving multi-scale bed topography on the near-bed velocity fluctuations. The two scaling ranges are separated by a spectral gap, i.e., a range of intermediate scales with no energy contribution. The high-frequency limit of the spectral gap corresponds to the integral scale of turbulence. The low-frequency end of the gap corresponds to the scale of the smallest bedforms identified by the velocity sensor, which depends on the position of the sensor. Comparison with spectral densities of bed elevations also shows that relatively low-resolution velocity measurements collected near the channel bed can be used to estimate the travel time of the largest bedforms.

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